Method and device for coding articles

The invention concerns a method of marking which is particularly suited for the failure-free tracing of commercial goods or value documents along a distribution chain.

Efficient technology for tracing of commercial goods and value documents is very important in a global economy, where the ease of movement of persons and goods is a vital issue. As to its practical aspects, the efficient tracing of a document or an item calls for a number of different technical issues to be individually solved and assembled together to an integrated system. A tracking system noteworthy requires:

(a)   the marking of the individual items to be tracked with information which is pertinent to their nature and origin;

(b)   the possibility of on-site machine-reading / authentication of the marking information contained on said items;

(c)   the possibility of transfer of the retrieved marking information to a remote data base;

(d)   the possibility for remote treatment of the retrieved data at a central data base.

Certain elements of the required technology are already available in the art and have been used in similar contexts. This holds in particular for the equipment used to read the marking information, for the telecommunication means used to transfer the information from and to a remote data base, and for the data base and its management itself.

US 5,918,910 deals with the marking and tracing of individual items in the aim to avoid confusion upon shipping and unpacking of a plurality of packed items. The system is based on a framed multi-part label, which carries the complete product information

printed or encoded on each of its parts. In particular, the label carries information concerning the machine at which the labeled product is to be installed. After transporting the labeled product to the machine, at least one part of the label is removed from the product and compared with the identifying information of the machine.

US 5,725,253 and US 5,607,187 deal with an identification system, involving the labeling and tracking of grouped items such as logs, shipping containers, or packets of mail, and reporting the current location of identified items during transport, processing and storage. The product information is preferably a machine-readable, redundant (with particular reference to Latin Squares) visible code, which is read and verified by image-processing means. The image-processing means can hereby be on-site or remote.

US 4,857,716 deals with a patient identification and verification system and corresponding method, for hospitals and related applications. The system includes a central computer containing a central data base, interconnected to a plurality of remote terminals by conventional telephone lines. The system further includes portable bar code reading devices including a bar code wand, an LCD display and a key pad. The portable bar code reading device communicates via RF transmission, modem and telephone line with the central computer, and is enabled to read patient identification bracelets, as well as identification labels attached to the various items used in the hospital. The retrieved information is automatically transmitted to the central data base, where it is correlated and stored appropriately.

None of the systems of the prior art has, however, addressed the specific technical problems and requirements which are connected with the tracing of authorization and liability items. In particular, security documents, currency, tax excise stamps, authorization labels, liability or warranty items, as well as the tracing of commercial goods, require (i) the capability of being authenticated, and (ii) 100% readability of the contained information. To enhance the document's or item's protection against counterfeiting attempts, the relevant information is furthermore (iii) preferably printed in a covert manner, i.e. invisible to the unaided human eye.

The above-mentioned requirements, in particular the requirement of 100% readability (no false negatives), calls for particular solutions, which are not provided up to now in the prior art. It is the object of the present invention to provide a method for the marking of individual items, such as security documents, currency, tax excise stamps, authorization labels, liability or warranty items, as well as particular commercial goods, which guarantees the capability of the printed information of being authenticate-able, a close to 100% readability through posterior validation, and allows as well for the covert application of the marking information, if desired.

It is a further object of the invention to provide a 'coding center' device embodying said method of marking, as well as enabling for the corresponding tracking & tracing of the marked documents or items through their registering in a centralized data base, using a data communication link.

These and further objects are solved by a marking method and a corresponding device as defined in the independent claims.

The method of marking according to the present invention noteworthy comprises the following steps:

a) Providing information to be applied to an item. Said information may be provided from any kind of source or generating means, such as a memory, a processor comprising a generating algorithm, or a data link to a remote server;

b) Applying a first marking, corresponding to said information provided, to the item. Said first marking may be applied to the item in any way, but preferably it is applied by a non-contact printing method such as ink-jet printing or laser marking, which allow for a rapid and flexible continuous marking operation;

c) Reading said first marking and information applied to said item in step b) and comparing it with the original information provided in step a);

d) Applying a second marking to said item if the first marking read in step c) does not correspond to the information provided in step a);

e) Optionally, affixing said item to a carrier or a transportation substrate prior to marking. This allows high-speed in-line processing of a plurality of items, such as stamps, labels, banderoles, small goods or packages and the like which are carried through the process on a carrier or transportation substrate, e.g. a band or sheet of carrier material. This also allows easy handling before and after marking. Applying labels, banderoles, stamps and the like after marking to goods results in indirect marking of any kind of voluminous or otherwise difficult to handle objects.

The steps of providing information, applying a first marking corresponding to the provided information, reading said first marking and information, and applying a second marking if said read information does not correspond to said information provided are carried out as a continuous operation on an equipment which is capable to perform these steps under the control of an electronic processor.

The initial marking may noteworthy be applied by printing, preferably of the non-impact type or by laser marking, but also by impact printing, embossing or punching, heating or transfer printing devices etc..

The reading of the information may rely on conventional opto-electronic means, such as a photocell (for reading a linear barcode), but also on a photocell array (for array barcodes) or on an electronic camera coupled to image processing means.

Preferably the information is applied in the form of a machine-readable code, such as a barcode, a number or other one- or more-dimensional codes.

In the second marking step, the original information on the item may be destroyed, e.g. by overprinting the first marking, or the second marking may simply be added to the item. The goal of the second marking is to declare the item as invalid in an intrinsic way, i.e. to prevent its later use. This can be performed by applying, e.g. printing something on it, as well as by taking something away of it, e.g. by mechanically or chemically or otherwise altering the item. As the second marking has the object of "canceling" the validity of the originally applied information – and, thereby, the marked item – the corresponding step is described in this specification as "canceling".

If the first marking, i.e. the application of the information, is performed by printing, the second marking is preferably also done by printing, more preferably by overprinting the original information or marking.

The comparison step can be performed in a known way using an information processing device. The output of said device may be used to initiate the canceling step if the provided and printed information do not correspond.

The pertinent information may be applied by printing onto the item, which may be a document, a piece of currency, a tax stamp, a label, a piece of packaging, an article, a transportation means etc. The information, which is preferably a customized information, may be printed using any of the known printing or application techniques, but in the context of the present invention, particular consideration is given to the 'variable-information-printing' techniques, such as ink-jet printing, toner-based printing or laser-marking, etc. The information to be applied or printed can be customized on-line, locally and/or remote, and applied to the item in question. In a preferred embodiment, said information is generated in a remote data base and transmitted to the 'coding center'. The information can furthermore be encrypted, or it may carry an encrypted part (such as a digital watermark), as known to the man skilled in the art. The printing medium (ink, toner, base-coating for laser-marking e.g. by heat marking or abrasion) preferably contains at least one material-based security element, and the marking, in the case of ink-jet printing, is preferably chosen covert, i.e. not visible to the unaided eye. Covert markings and one material-based security elements are e.g. based on

luminescent materials, magnetic materials, UV-absorbers, IR-
absorbers, etc.

The second step of the sequence, the reading, follows the
application or printing step, preferably immediately after the
first step has been carried out. It serves as a quality control,
which is particularly required if a variable-information
printing technique is employed in the printing step, and as
close as possible to 100% reliability of the final product has
to be achieved. The reading step is carried out by the
appropriate means, corresponding to the nature of the
information printed in the first step. If the information
printed in the first step is a linear barcode, a simple
photocell assembly, such as used in barcode readers, will be the
technology of choice. Multi-array barcodes will call for multi-
photocell-array assemblies; more complex printed patterns, such
as matrix codes, will require camera and image-processing means.
The information read from the marking in the second step is
decoded and compared with the information which should have been
printed in the first step.

If a misfit between read and should-have-printed information is
detected, it triggers the third step of the sequence, the in-
line canceling operation. The canceling is performed by a
canceling station, which applies a canceling mark to the item in
question, which may be a label, a tax banderole, a piece of
packaging, etc.. Preferably, an ink-jet station is used for the
canceling operation, and the item's invalidity is indicated by a
printing in vividly colored ink, comprising preferably also a
machine-readable component, such as a luminescent. This enables
a subsequent automated application of the valid items onto e.g.
commercial goods to be marked.

The 3-step in-line printing-reading-canceling sequence of the
present invention allows noteworthy to exclude all items
carrying a printing error, and to achieve therefore a close to
100% readability of the produced markings, even if they are
produced with variable-information-printing techniques. This is
of particular importance in the field of liability issues, where
only correctly printed items, e.g. part labels, are retained in
the central data base, or in the case of tax excise stamps,
where only correctly printed stamps are charged to the customer.

The invention discloses furthermore a coding center device
embodying the above-described print-read-cancel (PRC) sequence
method. The coding center is laid out such as to operate at high
throughput speed, and combines, in-line with a first printing
station, which is preferably an ink-jet printing station, a
control reading station, which is preferably based on camera and
image processing means, followed by a second printing station
for performing the canceling operation, if required. The second
printing station is preferably an ink-jet printing station, too.
The coding center embodying the PRC method is characterized in
that the items to be marked are moved on a same conveyor train
across the three stations of the PRC sequence, and that the
verification (control reading) of the printed marking and the
canceling operation, in case it is required, can be performed at
full printing speed. The coding center embodying the PRC method
further comprises the required digital processing means for
assigning the variable information to the printing station,
analyzing and comparing the control reading, and initiating the
canceling operation in case it is required. Said processing
means are preferably enabled as well for the book-keeping of the
successfully printed items, e.g. by logging them on a central
data base.

The items marked by the 'coding center' may themselves be
liability items, such as currency or ID-documents, or they may
serve to confer liability to another item, such as a piece of
pharmaceutical packaging, warranting its content, a label
affixed to a spare part, certifying its origin, or a seal for an
official document, standing for its genuineness. Finally the
marking may also be applied to selected commercial items, as
well as to transportation means, directly, or by the means of
packaging, labels, seals and the like, for mere tracking &
tracing purposes. Such application can be of benefit for the
study of market flows, as well as to fight diversion and
parallel trade.

In the following, the present invention is further illustrated
by reference to the accompanying drawings and non-limiting
examples.

Fig. 1   shows the schematic diagram of an exemplary embodiment
           of the coding center device according to the present
           invention and embodying the method of the present
           invention.

Fig. 2   shows a schematic diagram of performing a continuous
           in-line marking, reading and "canceling" sequence of
           items (1) under the control of a processor (IP): Items
           (1) on a conveyor (2), moving in direction (d), are
           imprinted at printing unit (P) with a first marking
           (3), which is read at reading unit (R). Items out-of-
           specification are imprinted at a canceling unit (C)
           with a canceling mark (4).

Examples

The coding center of a Track & Trace security system was
implemented as a customer-designed unit, which was assembled
from commercially available parts, as shown in Fig. 1. It
comprises a moving web (W) with motor (M), along which are
arranged in the moving direction which is indicated in Fig. 1 by
an arrow: a first detector cell (DC1), a printing head (P) with
printing head controller (PHC), a second detector dell (DC2), a
reading camera (RC) with reading camera controller (RCC), a
third detector cell (DC3), a canceling printing head (OP) with
canceling printing head controller (OPHC), and a quality control
detector cell (QDC). Further electrical units are required for
the operation of the conveyer belt (an electrical cabinet (EC),
a manual potentiometer (MP)), for the synchronization (encoder
E), and for the illumination of the reading camera (flashlights
F). The whole operation of the coding center is finally
controlled by the system's Computer (C), which is connected to a
central data base (Server (S)) via a Local Area Network (LAN)
having a transmission rate of more than 500 kB/s. The printing
head (P), the reading camera (RC) and the canceling printing
head (OP) are disposed from the detector cells (DC1, DC2 and
DC3) in a distance D1, D2, and D3, respectively, which is each
sufficient to allow the control of the printing head (P), the
reading camera (RC) and the canceling printing head (OP) by the
signals generated by DC1, DC2, and DC3, respectively.

Generally, the method comprises the following process steps:

1) The codes to be printed are generated by the computer (C) (which
   may receive them from the external server (S)) and sent to the
   printing head controller (PHC).

2) The first detector cell (DC1), upon detecting an item on the
   conveyor belt, sends a signal to the printing head controller
   (PHC).

3) The printing head controller (PHC), using the pulses generated
   by the encoder (E), determines the actual conveyor speed, and
   prints the information received from the computer (C) at the
   appropriate place and extension on the item to be marked which
   is moved on the conveyor belt.

4) When the item is detected by the second detector cell (DC2), the
   reading camera controller (RCC), using the pulses generated by
   the encoder (E), determines the actual conveyor speed, and at
   the appropriate moment activates synchronous flashes (F) and the
   camera (RC), to capture a digital image frame of the previously
   printed information.

5) The reading camera controller (RCC) decodes the captured image
   frame, retrieving its information , e.g. its alphanumerical
   code, and sending it to the controlling Computer (C). The
   controlling Computer (C) compares the information read with the
   information generated initially. If the two match, the
   information is taken for validated and sent to the external
   server (S) to be stored there as "good". In the opposite case,
   the code may also be stored on the external server (S) but
   marked as "bad".

6) If the code is "bad", the controlling Computer (C) sends a
   signal to the canceling printing head controller (OPHC), to
   print a visible canceling mark. The printing of the canceling
   mark is performed by the canceling printing head (OP) and
   triggered by a signal from the third detector cell (DC3) and by
   the pulses generated by the encoder (E), determining the actual
   conveyor speed and the location where to apply the mark.

7) An optional quality control detector cell (QDC) at the end of
   the print-read-cancel chain can be used to check if the

canceling mark was effectively applied on an item to be cancelled.

The process is in particular designed such as to cope with a varying conveyor speed. This requires the conveyor speed to be sensed by an encoder (E) and input into the different parts of the system, which need to calculate print locations and printing speeds, respectively. In this way, a variation of the conveyor speed will not influence the appearance of the printed information, and the coding center can simply be run up or shut down by the electrical controls of the main conveyor motor (M).

The process is implemented in the form of an operating program system, whose main part is running on the controlling Computer (C), with subsidiary parts running on the printing head controller (PHC), the reading camera controller (RCC), the canceling printing head controller (OPHC) and the remote data base (External Server).

In an exemplary embodiment according to the present invention, the coding center was designed as a 'narrow web' machine, of exterior dimensions (l x w x h) 2.1 x 1.5 x 1.5 m, running on a 220 V 50/60 Hz main power supply. It accepted roll paper for label applications, having a maximum width of 150 mm, and a paper weight ranging from 60 g/m^2 up to 100 g/m^2, conveyed at a choose-able speed range from 0 to 60 m/minute.

The detector cells were commercially available opto-electrical detectors of the type SICK reflex detector WT12-2, set up to detect the beginning of a label, or a specific mark on the roll paper.

The printing head controller was a commercially available DOMINO
A-200 system, controlling a DOMINO continuous ink-jet printing
head with electrostatic deflection. The same equipment is used
for the canceling station.

As the reading camera and the reading camera controller, a
DMxAUTOID-A1B2C2D3F012 system was used.

The controlling computer was embodied as a standard PC running
at 500 MHz clock rate, and equipped with local area network
(LAN) access and with the required number of serial ports. Four
of them were used for controlling the coding center, to
communicate i) with the printing head controller (PHC), ii) with
the reading camera controller (RCC), iii) with the canceling
printing head controller (OPHC), and iv) with the general
machine interface in the electrical cabinet (EC), for enabling a
totally automated operation of the coding center.

Fig. 2 shows labels (1) on a carrier band (2), moving in
printing direction (d). Said labels are imprinted at a first
ink-jet printing unit (P) with a first marking (3). Said
marking, a 2-dimensional barcode, corresponds to information
generated in processor (IP). The printed marking is subsequently
read and decoded with the help of an electronic camera with
built-in image processing facility (reading unit (R)). Processor
(IP) compares the result of the reading operation with the
information originally transmitted to printing unit (P). Items
with printing errors are in this way detected and imprinted at a
subsequent canceling ink-jet unit (C) with a canceling mark (4).

The marking 3 corresponds to information which is provided as
described in connection with Fig. 1, and which may either vary

from one item to another, or stay the same during certain
series.

The technical embodiment comprises as well all those
supplementary mechanical and electrical parts which are required
for its proper functioning, such as known to the skilled in the
art.

Based on the technical details of the present disclosure, the
skilled man in the art will be able to realize other embodiments
of the coding center, such as for 'wide web' printing, or for
sheet-fed operation. He will also be able to combine the
encoding center with supplementary operations, such as printing
and converting operations, as well as automated label or seal
application, or packaging operations, which may either precede
or follow the coding operation as disclosed in the present
invention.